



November 26, 2014

INDEPENDENT REVIEW OF 2014 DAM SAFETY INSPECTION REPORT

Snip Mine Tailings Dams

Submitted to:
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REPORT



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Executive Summary

Golder Associates Ltd. (Golder) was engaged by Barrick Gold Inc. (Barrick) to perform an independent review of the 2014 Dam Safety Inspection report for Snip Mine, BC, produced by Knight Piesold Ltd. (KP). The work was commissioned on September 23, 2014, in response to Golder's proposal P1412161-001-P-Rev0.

The independent review was required based on the *Notification of Chief Inspector's Orders – Tailings Dams – Independent Review of Dam Safety and Consequence Classification* from the British Columbia Ministry of Energy and Mines (BC MEM) dated August 18, 2014 (BC MEM 2014).

The scope of the review included the following:

- site visit by Mr. John Hull, P.Eng. on October 1, 2014, to observe the condition and status of the tailings dams; and
- review of the draft 2014 Dam Safety Inspection (DSI) report for the Snip Tailings Storage Facility produced by KP, reference VA101-2/17-1 Rev A, dated October 24, 2014 (KP 2014).

The findings of Golder's review are as follows:

- The DSI report prepared by KP generally addresses the elements required by the BC MEM (2012). However, there is no review of the 2014 climate data in the area of the tailings facility and a water balance was not developed based on the 2014 climate information.
- The dam consequence classification appears appropriate.
- The report provides a clear documentation of the status of the tailings dams.

The following actions are recommended:

- Barrick should continue to monitor and manage the beaver activity in the spillway to enable safe passage of any flood event from the Snip Tailings Storage Facility.
- The vegetation on Dykes 1 and 3 should be cleared on a more regular basis to enable clear view of the dams and future inspections.
- The monitoring instrumentation at the facility should be reviewed and, if needed, maintenance should be completed (Piezometer DH90-07).
- A Dam Safety Review should be completed in 2023.



Study Limitations

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1.0 INTRODUCTION

Golder Associates Ltd. (Golder) was engaged by Barrick Gold Inc. (Barrick) to perform an independent review of the 2014 Dam Safety Inspection (DSI) report for Snip Mine, BC, produced by Knight Piesold Ltd. (KP). The work was commissioned on September 23, 2014, in response to Golder's proposal P1412161-001-P-Rev0.

The independent review was required based on the *Notification of Chief Inspector's Orders – Tailings Dams – Independent Review of Dam Safety and Consequence Classification* from the British Columbia Ministry of Energy and Mines (BC MEM) dated August 18, 2014 (BC MEM 2014). This order states:

The mine manager must have the DSI reviewed by an independent qualified third party professional engineer from a firm that has not been associated with the tailings dam. The Independent Third Party Review of the DSI must also include a review of the dam consequence classification.

The scope of the review included the following:

- site visit by Mr. John Hull, P. Eng. on October 1, 2014, to observe condition and status of the tailings dams; and
- review of the draft 2014 DSI report for the Snip Tailings Storage Facility prepared by KP, reference VA101-2/17-1 Rev A and dated October 24, 2014 (KP 2014).

The independent review is not a Dam Safety Review as defined in the *Dam Safety Review Guidelines* produced by the BC Dam Safety Section (BC MEM 2012), in Section 5 of the *Canadian Dam Safety Guidelines* produced by the Canadian Dam Association (CDA 2013), and in the *Professional Practice Guidelines – Legislated Dam Safety Reviews in BC* produced by the Association of Professional Engineers BC (APEGBC 2014).



2.0 BACKGROUND

2.1 Site Description

Snip Mine was an underground operation, located some 320 km northwest of Smithers in northwest British Columbia. The mine was located in the mountainous terrain of the coastal mountains. The tailings facility layout is shown in Photograph 1.

The mine tailings facilities and dams are summarized in Table 1.

Table 1: Summary of Snip Tailings Storage Facility Dams

Impoundment	Tailings Dam	Status/Comments
Snip Tailings Storage Facility	Dyke 1	The pond is closed and a small pond is adjacent to Dyke 1
Snip Tailings Storage Facility	Dyke 3	The pond is closed and the pond now approaches the upstream face of Dyke 3

2.2 Design Consultant

The tailings storage facility design consultant during operation, closure, and early post-closure was Klohn Leonoff and Klohn Crippen Consultants Ltd. The tailings storage facility was designed in 1988, commissioned in 1991, and the mine operated until 1999. The tailings storage facility dams were raised in stages. The mine is owned by Barrick and the design consultant is understood to be KP, which carried out Dam Safety Inspections and Dam Safety Reviews from 2001 onward.

The preparation of this report by Golder does not impact the design consultant role held by KP.



3.0 INDEPENDENT REVIEW OF DAM SAFETY INSPECTION REPORT

3.1 Compliance with Ministry of Energy and Mines Requirements

The requirements for DSIs are presented in *Guidelines For Annual Dam Safety Inspection Reports* (BC MEM 2012). Table 2 summarizes the compliance or otherwise of the KP DSI report with the BC MEM requirements.

Table 2: Compliance of Dam Safety Inspection Report with British Columbia Ministry of Energy and Mines Dam Safety Inspection Requirements

Requirement	Included	Comment
Executive Summary		
Classification of the dam(s) in terms of Consequence of Failure in accordance with Table 2-1 of the CDA Dam Safety Guidelines (2013).	✓	Significant
a. Significant changes in instrumentation and/or visual monitoring records.	✓	
b. Significant changes to dam stability and/or surface water control.	✓	
c. For major impoundments, as defined in Part 10 of the Code, a current Operation, Maintenance and Surveillance (OMS) Manual is required. The annual report shall indicate the latest revision date of the OMS manual.	✓	
d. For tailings dams classified as High, Very High, or Extreme Consequence, an Emergency Preparedness Plan (EPP) is required. The annual report shall indicate the latest revision date of the EPP document.	✓	Not required
e. Scheduled date for the next formal Dam Safety Review in accordance with Table 5-1 of the CDA Dam Safety Guidelines (2013). Formal Dam Safety Reviews are required every 5 to 10 years (depending on consequence classification) and differ from annual dam safety inspections. The requirements for Dam Safety Reviews are included in Section 5 of the CDA Dam Safety Guidelines. Dam Safety Reviews may be conducted by the Engineer of Record with third party review, or by an independent third party with involvement of the Engineer of Record.	✓	
Summary of past years' construction (if any) with a description of any problems and stabilization	✓	
Plan and representative cross-sections	✓	
Site photographs	✓	
Review of climate data	x	No review of 2014 climate data
Water balance review	x	No water balance based on current configuration or present pond in TMF
Freeboard and storage availability (in excess of the design flood)	✓	
Water discharge system, volumes, and quality	✓	Water quality reported by Barrick
Seepage occurrence and water quality	✓	No seepage noted
Surface water control and surface erosion	✓	
Instrumentation review including: (a) Phreatic surfaces and piezometric data (b) Settlement (c) Lateral movement	✓	Instrumentation is in the dams to monitor phreatic surfaces, settlement or lateral movement.



3.2 Dam Consequence Classification

Tailings dams in British Columbia are regulated under the *Health, Safety and Reclamation Code for Mines in British Columbia* (BC MEMPR 2008), which references Canadian Dam Association (CDA) *Dam Safety Guidelines* (CDA 2007). The CDA (2007) dam consequence classification system is consistent with the revised CDA guidelines (CDA 2013).

Consequence categories are based on the incremental losses that a failure of the dam might inflict on downstream or upstream areas, or at the dam location itself. Incremental losses are those over and above losses that might have occurred in the same natural event or condition had the dam not failed. The classification assigned to a dam is the highest rank determined among the four loss categories.

Table 3 presents the dam classification criteria by CDA (2013).

Table 3: Dam Classification in Terms of Consequences of Failure

Dam Class	Population at Risk ^(a)	Incremental Losses		
		Loss of life ^(b)	Environmental and Cultural Values	Infrastructure and Economics
Low	None	0	Minimal short term loss. No long term loss.	Low economic losses; area contains limited infrastructure or service.
Significant	Temporary Only	Unspecified	No significant loss or deterioration of fish or wildlife habitat. Loss of marginal habitat only. Restoration or compensation in kind highly possible.	Losses to recreational facilities, seasonal workplaces, and infrequently used transport routes.
High	Permanent	10 or fewer	Significant loss or deterioration of important fish or wildlife habitat. Restoration or compensation in kind highly possible.	High economic losses affecting infrastructure, public transport, and commercial facilities.
Very High	Permanent	100 or fewer	Significant loss or deterioration of critical fish or wildlife habitat. Restoration or compensation in kind possible but impractical.	Very high economic losses affecting important infrastructure or services (e.g., highway, industrial facility, storage facilities for dangerous substances).
Extreme	Permanent	More than 100	Major loss of critical fish or wildlife habitat. Restoration or compensation in kind impossible.	Extreme losses affecting critical infrastructure or services (e.g., hospital, major industrial complex, major storage facilities for dangerous substances).

Source: CDA (2013).

a) Definition for population at risk:

None – There is no identifiable population at risk, so there is no possibility of loss of life other than through unforeseeable misadventure.

Temporary – People are only temporarily in the dam-breach inundation zone (e.g., seasonal cottage use, passing through on transportation routes, participating in recreational activities).

Permanent – The population at risk is ordinarily located in the dam-breach inundation zone (e.g., as permanent residents); three consequence classes (high, very high, extreme) are proposed to allow for more detailed estimates of potential loss of life (to assist in decision-making if the appropriate analysis is carried out).

b) Implications for loss of life:

Unspecified – The appropriate level of safety required a dam where people are temporarily at risk depends on the number of people, the exposure time, the nature of their activity, and other conditions. A higher class could be appropriate, depending on the requirements. However, the design flood requirement, for example, might not be higher if the temporary population is not likely to be present during the flood season.

CDA = Canadian Dam Association.



The tailings storage facility is located in a low valley with relatively small dam structures – Dykes 1 and 3. The site is in a remote area of northwest BC and the closest structure is an abandoned airstrip 1.2 km downstream from Dyke 3. The dams are zoned structures consisting of a low permeability core and rock/earthfill shells. The consequence of a failure would have low to no risk to population and the consequence to the environment and any economic loss is also rated as low. The dams are classified as Significant based on CDA guidelines. The 2014 DSI (KP 2014) reassessed the dam classifications and confirmed the previous 2013 Dam Safety Review dam classifications. On this basis, the dam classifications of the Snip Mine tailings dams are assessed as shown in Table 4.

Table 4: Dam Consequence Classifications

Dam	Population at Risk	Incremental Losses		Dam Consequence Classification
		Environmental and Cultural Values	Infrastructure and Economics	
Dyke 1	Temporary Only	No significant loss or deterioration of fish or wildlife habitat. Restoration or compensation in kind highly possible.	Losses to recreational facilities, seasonal work places and infrequent used transport routes.	Significant
Dyke 3	Temporary Only	No significant loss or deterioration of fish or wildlife habitat. Restoration or compensation in kind highly possible.	Losses to recreational facilities, seasonal work places and infrequent used transport routes.	Significant

The consequence of failure is considered to be consistent with the classification assigned by KP (2014). The dam classifications assigned by KP (2014) are considered appropriate.

A dam breach study has not been completed and is not required for significant consequence structures.

The dam consequence classification typically influences the selection of the design earthquake, design flood event, and the frequency for Dam Safety Reviews. The 2014 DSI (KP 2014) reassessed the dam classification and checked the proposed design events for earthquakes and flood events with respect to the CDA (2014) criteria for closure – active care facilities.



3.3 Observations from Site Visit

Photographs from the October 1, 2014, site visit are presented in Appendix A.

Observations that present potential dam safety concerns include the following:

- The spillway channel at Dyke 1 is clear of vegetation, but a beaver has built a small dam at the inlet to the spillway. The pipe installed to bypass the beaver dam is working well. The spillway should be cleared and the beaver activity monitored and managed (see Photographs 2, 3, and 4 in Appendix A).
- The downstream slope of Dyke 1 has been recently cleared of vegetation and this effort should continue. The access path to the lower end of the spillway should be improved to enable safe access to the monitoring station downstream.
- The monitoring weir downstream of Dyke 1 is flooded. If the conditions downstream do not change in early 2015 and the weir is required for on-going monitoring, the back water condition should be investigated so the weir will operate as required (see Photograph 5 in Appendix A).
- The upstream slope, crest, and downstream slope of Dyke 3 should be cleared to allow improved regular inspections when water quality samples are collected on a quarterly basis. The clearing completed on Dyke 3 for the October 1, 2014, inspection was a good start (see Photograph 6 in Appendix A).



4.0 FINDINGS AND RECOMMENDATIONS

4.1 General Findings

The general findings of Golder's review are as follows:

- The DSI report prepared by Knight Piesold Ltd. (KP 2014) generally addresses the elements required by the BC MEM (2012), with the exception that there was no review of the 2014 climate data and no current or updated water balance for the facility.
- The dam consequence classification appears appropriate.
- The DSI report (KP 2014) provides an interpretation of the impact of recent CDA guidelines with respect to the Snip Tailings Storage Facility. The report describes the current status and performance of the tailings dams and reviews the facility with respect to new guidelines from October 2014 (CDA 2014).

4.2 Instrumentation

The instrumentation in the dam was not checked for the 2014 DSI (KP 2014). Data for the piezometers in the two dykes were reviewed from the 2013 DSI. The review indicated that the phreatic surfaces in the two dykes were consistent with previous readings and that the dykes were performing as predicted for the closed facility with a small pond. It was noted that one piezometer should be checked or repaired (DH90-07).

4.3 Prioritization of Recommended Action Items

Several actions are recommended by KP (2014), including clearing of vegetation, monitoring of the spillway to detect and remove beaver dams, and maintenance to piezometers. Golder notes that none of recommendations relate to immediate dam safety concerns, and the recommendations should be managed in 2015.



5.0 REPORT CLOSURE

We trust that this Independent Review of the 2014 Dam Safety Inspection Report of the Snip Tailings Storage Facility dams (KP 2014) meets your requirements. Please contact the undersigned if you require additional information regarding this review.

GOLDER ASSOCIATES LTD.

Reviewed by:

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APPENDIX A

Photographs



APPENDIX A PHOTOGRAPHS



Photograph 1: Site Overview - Dyke 1 In Foreground, October 1, 2014



Photograph 2: Beaver Lodge In Pond Near Dyke 1, October 1, 2014



APPENDIX A PHOTOGRAPHS



Photograph 3: Spillway Inlet, October 1, 2014



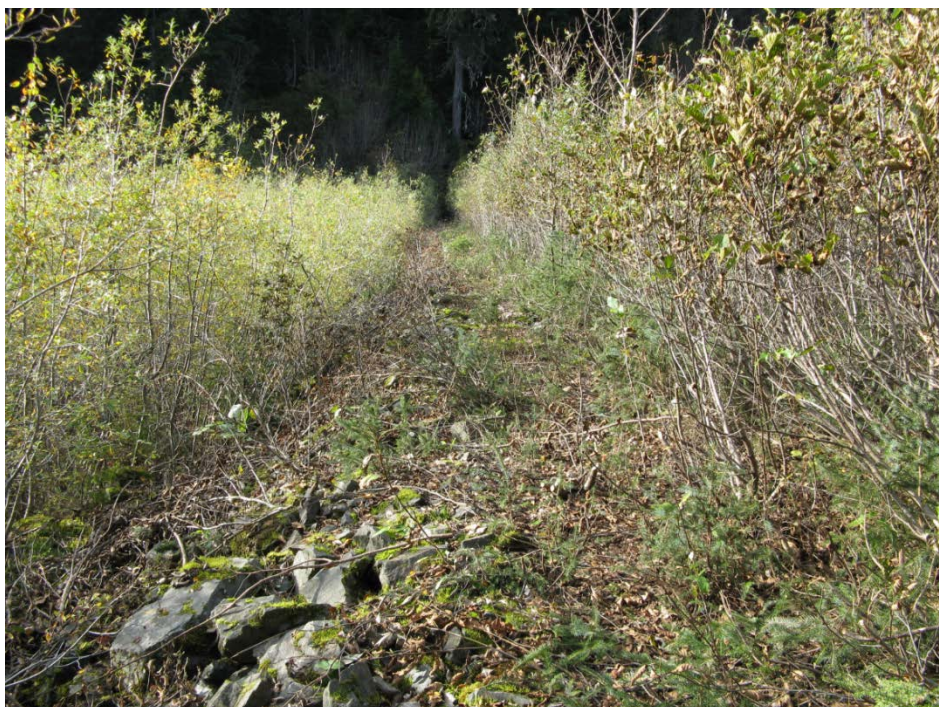
Photograph 4: Beaver Dam in Spillway with bypass pipe in center of spillway, October 1, 2014



APPENDIX A PHOTOGRAPHS



Photograph 5: Weir Downstream of Dyke 1, October 1, 2014



Photograph 6: Dyke 3 Dam Crest – Partially Cleared, October 1, 2014

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